Geospatial Utility Infrastructure Data Exchange Procedural Manual

GUIDE

GEOSPATIAL UTILITY INFRASTRUCTURE DATA EXCHANGE

MDOT | Michigan Department of Transportation

MDOT
Michigan Department of Transportation

DRAFT
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1 PROCESS OVERVIEW

1.1 PURPOSE STATEMENT

Geospatial Utility Infrastructure Data Exchange (GUIDE) creates an organized and sustainable approach to data collection, management, and dissemination of 3D geospatial data on underground utility infrastructure by capturing accurate XYZ information at the time of installation and organizes it in a spatial database format for secure, highly accessible use by downstream stakeholders.

1.2 PROGRAM SUMMARY

The Michigan Department of Transportation's (MDOT) GUIDE program requires permit applicants to capture the geospatial location of permitted underground utility installations installed within the MDOT right of way. GUIDE requires the submittal of all data in an absolute coordinate system and relative to a defined vertical datum, which allows data that is recorded relative to an absolute datum to be repeated consistently throughout time. Therefore, as spatial reference frames change in the future, data relative to an absolute coordinate system can always be repeated.

At the time of permit issuance, MDOT will determine which applicants must follow GUIDE standards. GUIDE standards will be conditional to each permit, and instructional information will be included. The permit applicant, or its designated consultant, will be responsible for the acquisition of survey data, coordination with construction personnel, data file preparation, quality assurance and quality control, and data submission according to GUIDE standards.

1.3 GUIDE PROCESS

Figure 1 is a flow chart depicting the typical GUIDE workflow beginning with MDOT permit issuance.

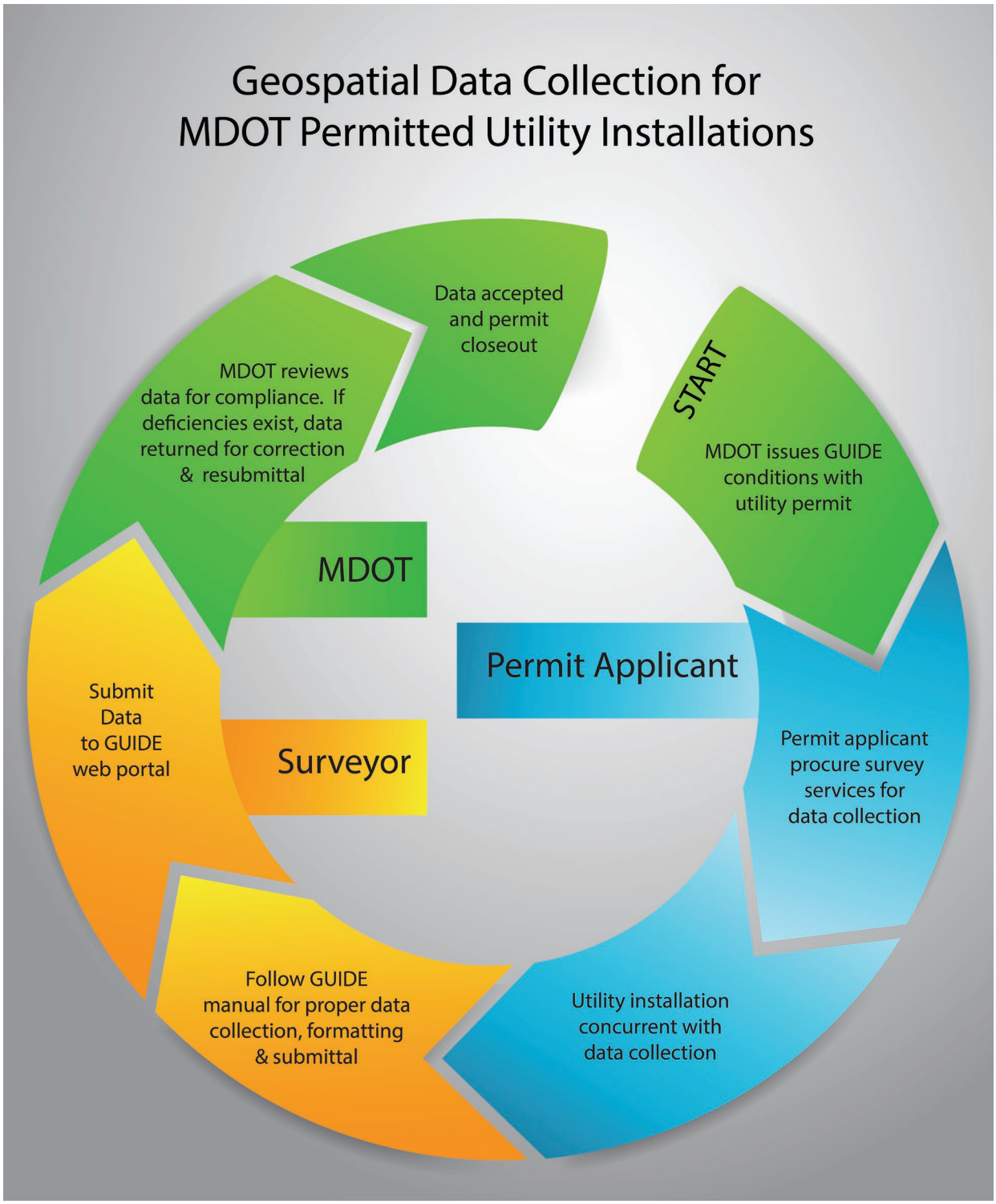


Figure 1

1.3.1 MDOT RESPONSIBILITIES

1. Issue utility permit with GUIDE conditions
2. Review and accept or reject data submitted by permit applicant
3. Close out the applicant's permit if conditions of the permit have been fulfilled

1.3.2 PERMIT APPLICANT RESPONSIBILITIES

1. Request access to the GUIDE web portal
2. Coordinate with construction personnel to comply with GUIDE standards
3. Collect data concurrently with the utility installation according to GUIDE standards
4. Check and validate the data collected
5. Submit the data collected to the GUIDE web portal for acceptance. Resubmit with corrections if required.

2 FIELD

This section of the manual discusses the field component of GUIDE data collection and what tasks are required. Data collected for GUIDE will follow the standards described in this document to achieve data acceptance.

2.1 DATA COLLECTION STANDARDS AND OBSERVATION STANDARDS

2.1.1 UTILITIES COLLECTED

Table 1 contains a list of utility types accounted for within GUIDE standards including a description of what facilities are intended to be surveyed.

Utility Type	Feature Code	Description of Utilities
Brine	BRNE	Brine transmission, distribution, service lines, and appurtenances within defined size parameter
Chilled Water	CHW	Chilled water transmission, distribution, service lines, and appurtenances within defined size parameter
Communication	COMM	All communication facilities, including fiber optic, copper, coaxial, including appurtenances within defined size parameter
Gas	GAS	Natural gas transmission, distribution, service lines, and appurtenances within defined size parameter
Electric	ELEC	Secondary electric or higher voltage
Pipe	PIPE	Pipeline facilities, including crude oil, refined oil, or all other types of oil pipeline transmission, distribution, service lines, and appurtenances within defined size parameter
Propane	PROP	Propane transmission, distribution and service lines, and appurtenances within defined size parameter
Sanitary Sewer	SANI	Sanitary sewer facilities including all mains, collection system, forcemains, services and leads, including appurtenances within defined size parameter. (Combined sewer is classified as sanitary sewer)
Steam	STEA	Steam transmission, distribution, service lines, and appurtenances within defined size parameter
Storm Sewer	STRM	Storm sewer facilities including all mains and collection system, including appurtenances within defined size parameter. (Excludes underdrain)

Water	WATR	Water transmission, distribution, service lines, and appurtenances within defined size parameter. (Excludes irrigations systems)
Other	OTHR	This designation can be used for those facilities not covered by the above feature codes, including but not limited to industrial facilities of all types and discovered utilities where the type of utility is unknown.

Table 1

2.1.2 WHEN GUIDE DATA IS COLLECTED

All utilities will be surveyed in three dimensions concurrent with the installation of each utility in order to comply with the standards described herein.

2.1.3 WHO COLLECTS GUIDE DATA

Data will be collected under the direct supervision of a Michigan-licensed professional surveyor. The license number of the professional surveyor responsible for data collection efforts will be stored as an attribute for each utility feature as described in section 2.2.1.

2.1.4 WHO COORDINATES DATA COLLECTION

It is the permit applicant's responsibility to coordinate with a surveyor to collect data compliant with GUIDE standards. The surveyor can be an external or internal resource. The permit applicant and its designated surveyor will be responsible for coordinating and assigning daily surveying activities, data processing, formatting, QA/QC, and data submittal.

Coordination with construction activities is required in order to collect the required spatial and attribute data compliant with GUIDE standards.

2.1.5 REQUIRED DATUMS AND COORDINATE SYSTEMS

Horizontal Datum: **The North American Datum of 1983, 2011 Adjustment** (NAD 83) and the Geodetic Reference System of 1980, (GRS80).

Vertical Datum: **The North American Vertical Datum of 1988**, (NAVD 88) RTK GPS is an acceptable method to derive NAVD 88 elevations and is the Vertical Datum that is used for all projects performed for MDOT. Use the latest Geoid model from NGS to compute orthometric heights. As of 2019, the latest Geoid model that is acceptable is Geoid12B.

Coordinate Systems: Use the Michigan State Plane Coordinate system on all projects, and use the appropriate zone based on the project location (North, Central, or South)

Units: International feet (1 foot = 0.3048 m)

For additional information on Horizontal and Vertical Data, visit section 3.1 of MDOT's Survey Standard of Practice.

2.1.6 SURVEY OBSERVATION STANDARDS

Data collected for GUIDE represents the actual XYZ location of the installed utility, where Z represents the elevation of the top of the pipe or conduit, as shown in Figure 2. A direct observation (preferred) or an indirect observation will be required to achieve an absolute XYZ position that represents the top of the utility.

2.1.6.1 DIRECT SURVEY OBSERVATION (FIGURE 2)

In a direct observation, a surveyor places the surveying instrument directly on the utility and records the XYZ position. This type of observation is commonly achievable if utilities are installed via open excavation methods, or at bore pits and tie in locations where trenchless technologies are used. Data collection of directly observed utilities yield the highest level of confidence but requires daily coordination with construction activities so the field surveyor can physically observe the utility at the required locations prior to backfilling.

2.1.6.2 INDIRECT SURVEY OBSERVATION (FIGURE 3)

Common installation methods include various trenchless technologies, which prevent the direct observation of installed utilities. The following are common methods of coordination of data collection aimed at producing high-level data collection results.

Field Witnessing: For trenchless installation methods, observe and survey all tie-in locations, bore pits, or any other areas where the utility is directly exposed. Construction crews must witness the location and depth of the installed utility during mainline trenchless operations. Field witnessing needs to consist of physical marks in the field so that a field surveyor can record a survey observation at the centerline of the utility on the ground, then compute the elevation of the utility by subtracting the field-witnessed depth from the ground elevation. Figure 3 is an example of field witnessing a trenchless utility installation. A horizontal directional drilled (HDD) fiber optic line is documented with a wood stake, marking the centerline of the utility with the depth reading from the bore head written on the stake. Surveyors must record a spatial position at the base of the wood stake, then compute the elevation of the top of the utility. Use permanent witness marks to limit the chance of disturbance prior to the data collection activity. Take into account the diameter of the utility and the general position of the bore head with respect to the utility.

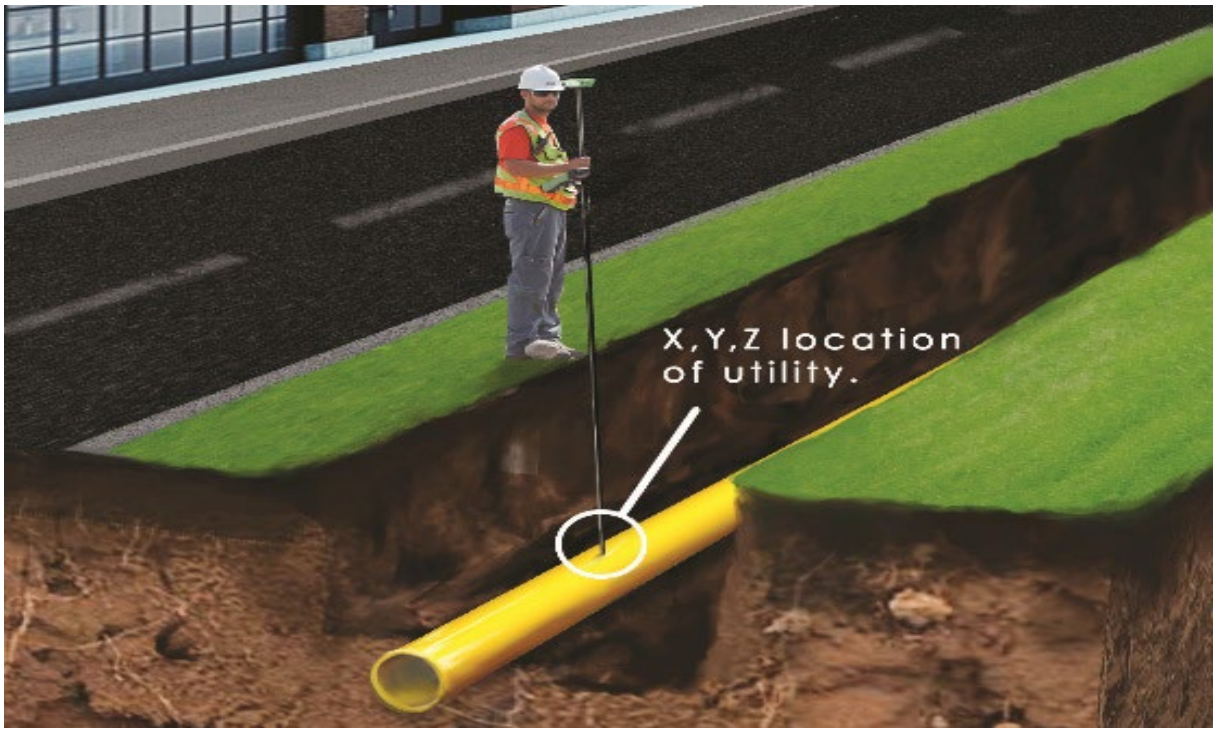


Figure 2

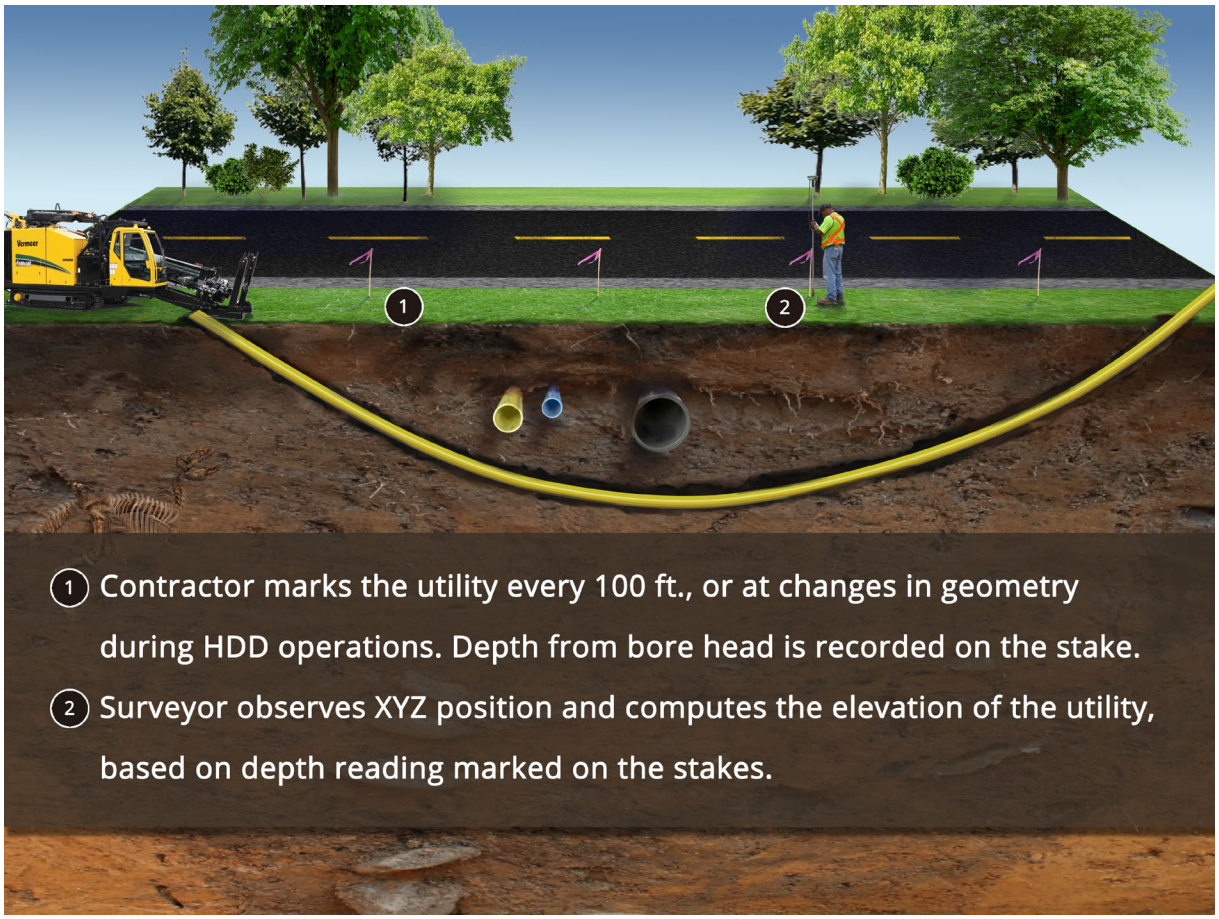


Figure 3

2.1.6.3 GENERAL OBSERVATION STANDARDS

1. All transmission, distribution and collector system main lines
    a. Start and end points
    b. Minimum of every 100 feet with the following additional points
        i. Deviations in installation alignment (horizontal and vertical) including but not limited to the following:
            a. Intentional changes in geometry such as changing direction to avoid obstacles
            b. Fittings such as elbows (horizontal and vertical)
        ii. Changes in facility characteristics (e.g. Change in size, material, number or pair, encasement size, material, etc...)
        iii. Start and end point for vaults
2. Appurtenances installed concurrently with new main installations, whereas appurtenances are defined as service leads and stubs.
    a. Tap-in at the main and at (near) the right of way line[1]
3. New appurtenances from existing mains
    a. See Table 2 for required size parameters for each utility type
    b. Tap-in at main and at (near) the right of way line
4. Transverse utility crossings installed via trenchless methods
    a. All qualified utilities crossing roads as described in section 2.1.6.4.
    b. 25-foot intervals across pavement sections when safely achievable

[1] Legal right of way limits do not need to be determined for GUIDE in order to collect an observation at the right of way. The intent is to collect a point near the right of way, at the main, and at the appropriate interval along the appurtenance in order to represent the utility feature to near the right of way.

Utility Type	Feature Code	Size Parameter for Appurtenances Installed from Existing Mains
Brine	BRNE	2” or larger
Chilled Water	CHW	2” or larger
Communication	COMM	Fiber optic or copper cables 25 pair or greater
Gas	GAS	2” or larger
Electric	ELEC	Secondary or higher voltage
Pipe	PIPE	2” or larger
Propane	PROP	2” or larger
Sanitary Sewer	SANI	4” or larger
Steam	STEA	2” or larger
Storm Sewer	STRM	6” or larger
Water	WATR	2” or larger
Other	OTHR	Use professional judgement to determine appropriate size parameter, using a risk-based analysis. EXAMPLE: An industrial oxygen line 2” in diameter should be surveyed because it is a high-risk utility. Conversely, a 2” diameter plastic irrigation line doesn’t need to be surveyed, because it is considered a low-risk utility.

Table 2

2.1.6.4 UNIQUE REQUIREMENTS FOR TRENCHLESS INSTALLATIONS ON TRANSVERSE UTILITY CROSSINGS

Certain transverse utility crossings may require deviation from the GUIDE standard in order to maintain a safe work environment. If there are no safe methods of field witnessing the boring location and depth within a pavement section, collect a survey observation at or near the edge of pavement before crossing the pavement section. Then continue by collecting a survey observation at or near the opposite edge of pavement and continue per the normal observation procedures previously described.

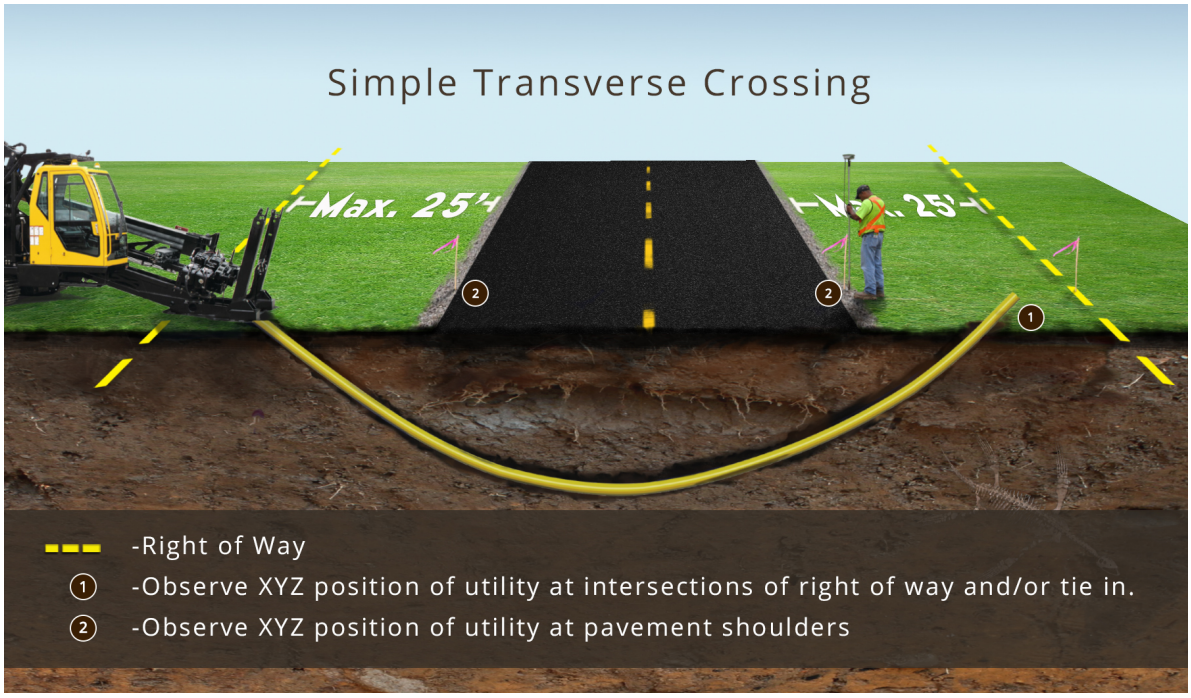


Figure 4

All other transverse utility crossings that are installed using methods conducive to a direct survey observation require survey observations to be collected at a minimum of 25-foot intervals when crossing a pavement section. Additionally, all utilities will be directly observed when installed using a method that support direct observation.

All utilities installed by trenchless technologies must be observed directly above the installed utility with the elevation computed from the best available depth readings (typically depths read from bore head during installation). The accuracy of the depth readings to the installed utility will vary depending on the type of equipment used during installation.

Direct survey observations are required where utilities are exposed including tie-in locations, bore pits, hand holes, and manholes. Alignment and depth will be documented during boring operations at the required interval. Some form of field witnessing must be used to mark the horizontal location and depth of the utility based on readings from the equipment being used. Then, the surveyor can survey each marked location and compute the elevation of the installed facility based on the recorded depth readings at each surveyed location. At a minimum, alignment and depths must be physically documented at an interval of not more than 100 feet and at all changes in horizontal and vertical alignment. The more survey observations collected along a utility line, the better the true three-dimensional alignment of the utility will be represented. For example, long and deep bores could create a parabolic curve shaped utility that will not be accurately represented with point spacing at 100 feet. Use professional judgement and collect additional points at a closer interval to generate a more representative geometry of the utility. Figure 4 depicts a simple transverse crossing. Figure 5 depicts two scenarios for complex transverse crossings.

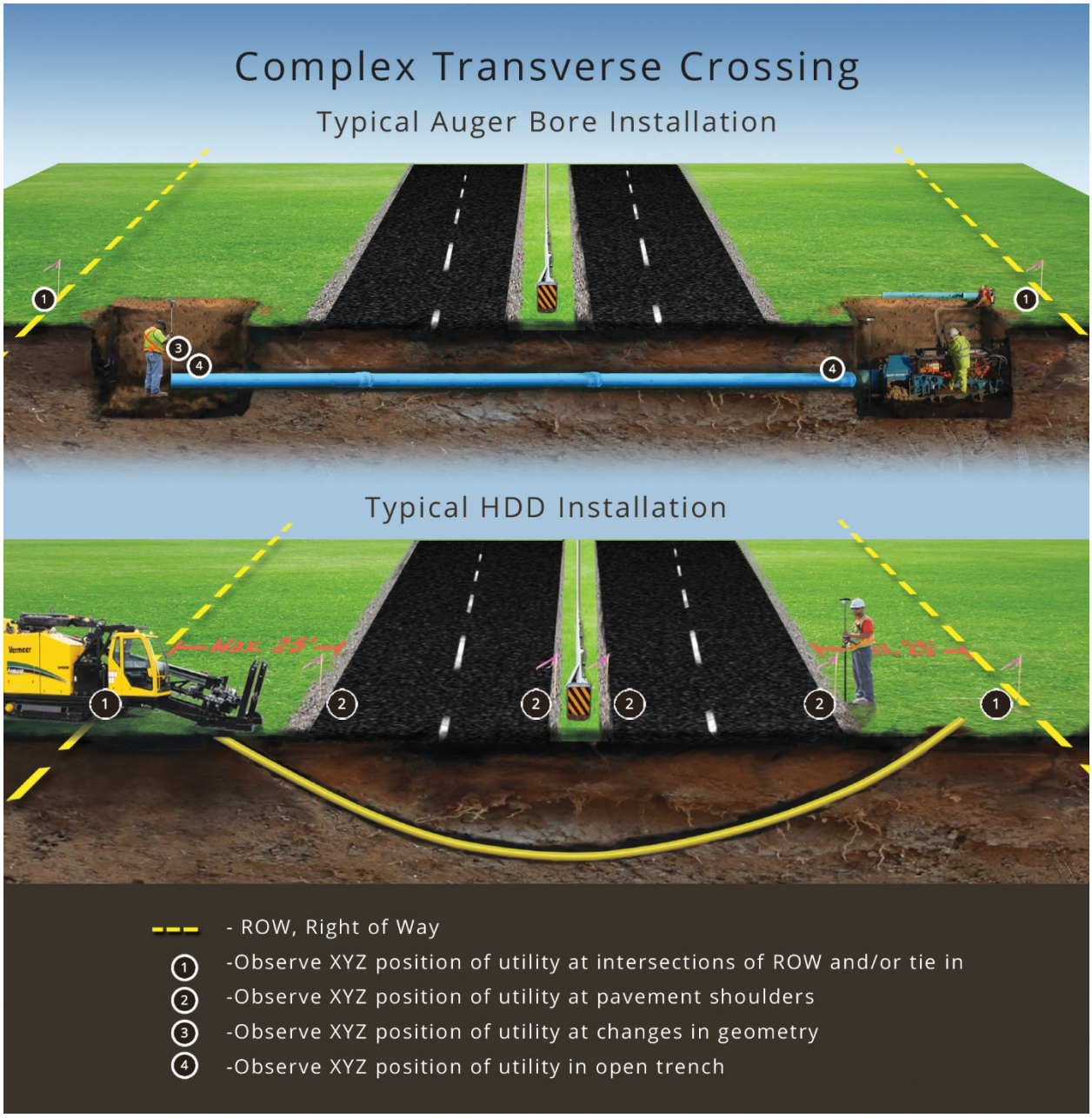


Figure 5

2.1.6.5 DISCOVERED UTILITIES

The standards contained herein, contain provisions for utilities that have been discovered and exposed during construction activities. As a courtesy to future stakeholders, MDOT requests that permit applicants direct their surveyor to survey any existing utilities that are exposed during construction. Use the attributes and corresponding domain values in Table 3 to handle discovered utilities.

Attribute Name	Attribute Description	Domain Value
UtilComp	Utility Company	Unknown – Most likely the owner of the discovered facility will be unknown. If known, please select the appropriate option
UtilType	Utility Type	Unknown – At the time of discovery, it is likely the type of utility will be unknown. If known, please select the appropriate utility type.

Table 3

For utilities discovered in potholed situations, a surveyor should record two observations as far apart as the hole will allow.

2.1.7 ACCURACY STANDARDS

All data collected for GUIDE is considered survey-grade absolute accuracy. Specified accuracies are within the realm of what is consistently achievable with RTK GPS techniques when proper surveying principles are employed.

- Horizontal Accuracy: 0.16’ (5cm)
- Vertical Accuracy: 0.16’ (5cm)

2.2 DATA DICTIONARY/DATABASE SCHEMA

The geodatabase schema has been developed within the Esri ArcGIS 10.3.1 environment and has been developed as an enterprise geodatabase. The general structure of the geodatabase consists of a feature dataset for each Michigan State Plane Zone and feature classes for each utility type that resides within each feature dataset. Figure 6 shows the general database structure. Identical attribute fields within each feature class are listed in section 2.2.1.

General Geodatabase Structure

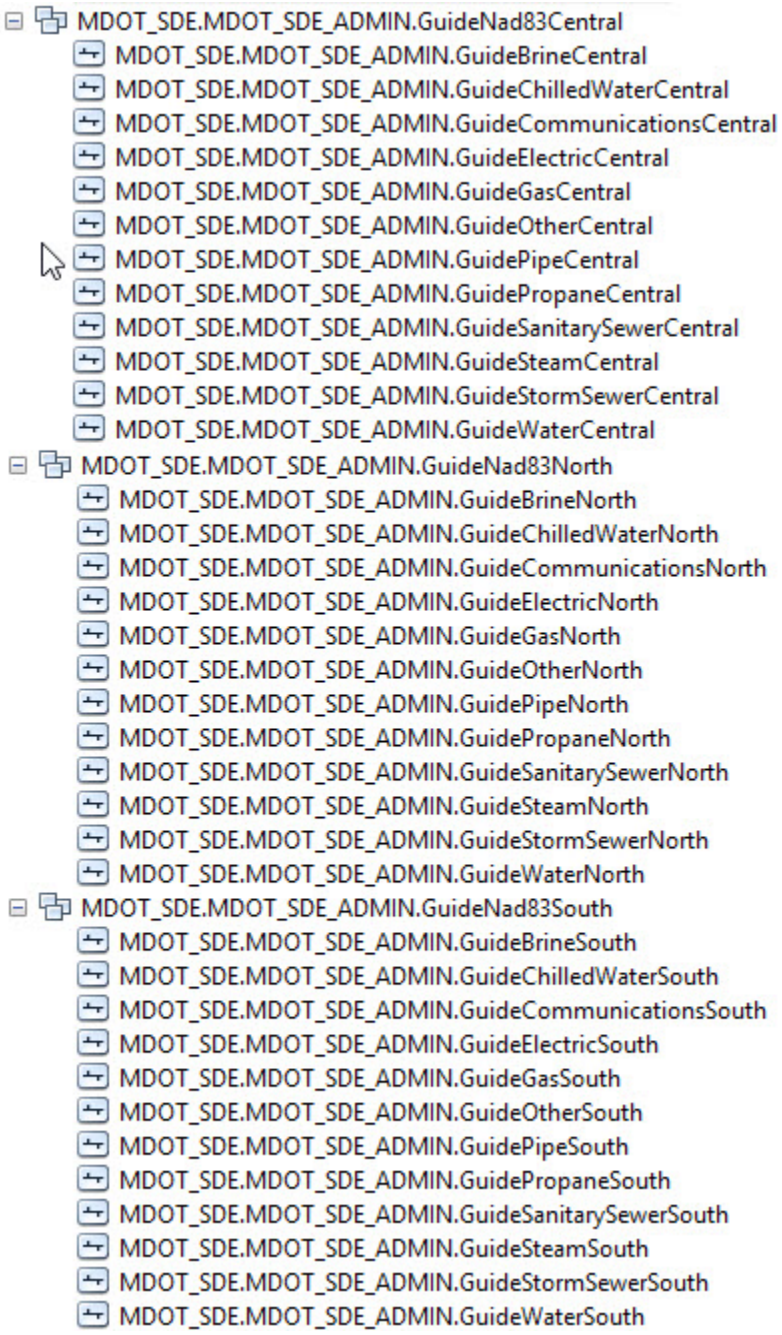


Figure 6

2.2.1 DOCUMENTATION OF DATABASE SCHEMA

All feature classes listed in Figure 6 have the same attributes. A list of these attribute fields are shown in Table 4. Most fields include a list of predetermined values called domains. Each attribute field is described in further detail in Table 5.

Feature Class Attribute Fields

Field Name	Alias Name	Type	Length	Required (Y/N)
OBJECTID	OBJECTID	OID	4	N
SHAPE	SHAPE	Geometry	0	N
AssetID	Unique Global Asset ID (auto generated)	String	25	N
SegID	Surveyors Unique Line Segment ID during Field coding	String	10	Y
UtilComp	Utility Company Name from MISS DIG Design Ticket Database	String	50	Y
MDOTPer	MDOT Permit Number (if applicable)	Integer	4	N
InstMeth	Installation Method	String	40	Y
LicNum	Surveyors Professional License Number	Integer	4	Y
CollecBy	Name of Company Data Collected By	String	30	Y
SurvInit	Surveyor Initials	String	3	Y
MethLoc	Method of Location Technology Installed on Utility	String	20	Y
FeaType	Feature Type	String	10	Y
UtilType	Utility Type	String	20	Y
InstDate	Date of Utility Installation	Date	8	Y
UtilMat	Utility Material	String	20	Y
FacShape	Shape of the Installed Utility	String	10	Y
UtilDia	Utility Diameter	String	25	Y
ParaQT	Quantity of Same Size Utility Installed	Integer	2	Y
Encas	Encasement (Yes or No)	String	3	Y
SueQL	Equivalent SUE Quality Level	String	1	Y
EncasMat	Encasement Material	String	10	Y
EncasDia	Encasement Diameter	String	25	Y
Notes	Any Special Notes	String	500	N
SHAPE_Length	SHAPE_Length	Double	8	N

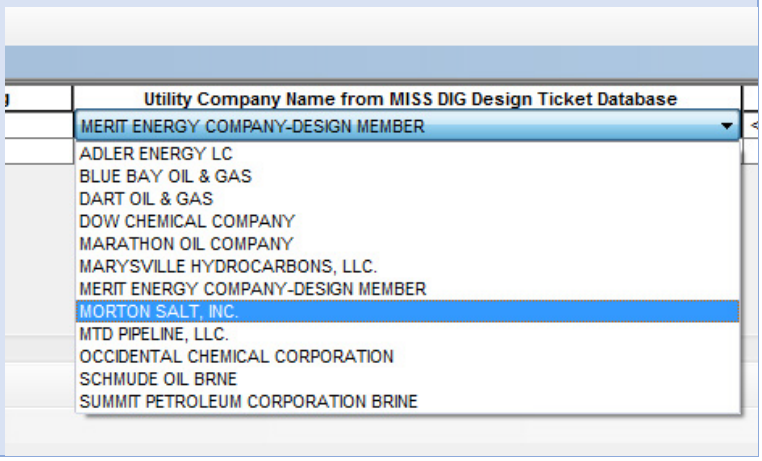
Table 4

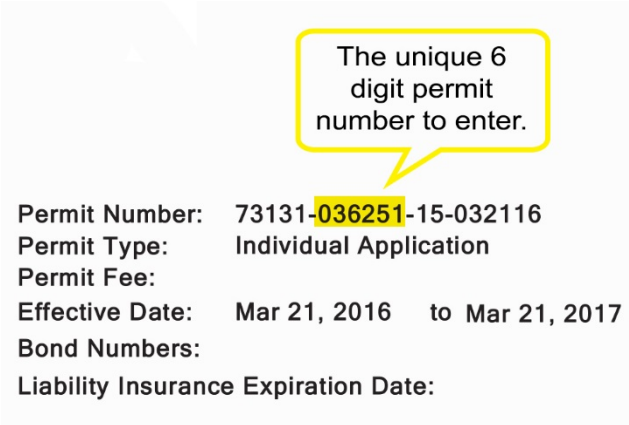
Most attribute fields have been created with a prepopulated pull-down list of available options (Domains) within ArcGIS. These domains can be used to create a data dictionary that mirrors the GUIDE attribution and domain options. All values including attributes,

domains, field types, and character length must match the sample GUIDE geodatabase linked in section 2.2.4. The file will be automatically rejected upon submittal to the GUIDE web portal if the shapefile prepared from field data is not properly formatted with exact matching fields.

Table 5 provides a description of each available field, its name, and its intended use within the GUIDE standards.

Available Attribute Fields

Name	Code	Description of Use
Asset ID	AssetID	This field will be automatically populated after uploading the data to the GUIDE portal. This field must exist in the shapefile being uploaded, however its value must be blank. The unique Asset ID will be created through a concatenation of the following fields: (FeaType,InstDate,SegID) – (BRNE20160404MKU1)
Segment ID	SegID	This field is a unique ID used by the surveyor to identify each line segment located. Can be numeric or alpha numeric.
Utility Company	UtilComp	The domain options for this field originate from the MISS DIG design ticket system. For example, if a user selects "Consumers Energy" the MISS DIG design code for Consumers Energy of DSGCE will be populated in the database. If a utility company installing the utility is not in this list, it must contact MISS DIG. 

MDOT Permit Number	MDOTPer	This is the second group of 6 characters from the left of the overall MDOT permit number shown in the upper right corner of an MDOT utility permit, shown in the figure below. 
Installation Method	InstMeth	See Appendix 1 for a detailed description of each method. • HDD (Horizontal Directional Drilling) • Open Cut • Plowed • Jacking • Boring • Micro Tunneling • Insertion • Discovered
License Number	LicNum	Enter the 5-digit Michigan Professional Surveyor license number of the surveyor in responsible charge of the data collection.
Surveyors Initial	SurvInit	The 2 or 3 character initials of the surveyor in responsible charge of the data collection.
Company Collected By	ColecBy	The name of the survey company of permit applicant responsible for the actual data collection efforts.
Location Method	MethLoc	The type of utility-locating technology that has been installed on the utility to facilitate future locating. The available domain options are as follows: • Facility: Use this value when the facility has characteristics inherent to itself which allow for future recovery, such as magnetic field due to its material properties • Tracer Wire: Select if tracer wire has been installed • Tracer Tape: Select if tracer tape has been installed • RFID: Select if radio frequency identification technology has been installed • Marker Ball: Select if marker ball technology has been installed • Magnetic: Select if the facility has a magnetic field that can be located due to its inherent material properties

		• Geospatial: Select if no other locating technology has been installed, however the facility may be located in the future using the 3D geospatial position collected as a part of the GUIDE standards
Feature Type	FeaType	Select the appropriate utility feature type from the list of available options. • BRNE - Brine • CHW – Chilled Water • COMM – Communications • ELEC - Electric • GAS – Gas • PIPE - Pipeline • PROP - Propane • SANI – Sanitary Sewer • STEAM - Steam • STRM – Storm Sewer • WATR - Watermain • OTHR – Industrial or all other
Utility Type	UtilType	Select the appropriate utility type from the list of available options. • Transmission • Distribution • Service • Non-disclosed or Not-Applicable • Collection
Installation Date	InstDate	Enter the installation date of the utility. • The date must be entered according to the following format (YYYYMMDD)
Utility Material	UtilMat	Select the appropriate material of the utility being installed. Exceptions are described below: • For communication facilities, multiple encasements need to be denoted. In the case of a conduit within a conduit, the material selection needs to be the primary conduit material. If there are multiple conduits bound together, then the ParaQT field will denote the number of conduits of similar size. If those conduits are not inside an encasement, select “NO” under the encasement attribute field. If those conduits are within a larger diameter conduit, select “YES” under the encasement attribute field. Also select the appropriate encasement material and size under the encasement attribute fields • In the event that a fiber optic, copper or coaxial cable are direct buried, then select either “Fiber optic” or “Copper”

		for attribute "UtilMat". Select "NO" under the encasement attribute field.[2]
Facility Shape	FacShape	Select the most appropriate option that denotes the shape of the utility being installed. Available options are shown below: • Round • Rect – For rectangular shaped facilities. Most commonly used for rectangular shaped pre-cast multiducts • Square – For square shaped facilities. Most commonly used for square shaped pre-cast multiducts • Elliptical
Utility Diameter	UtilDia	Enter the maximum outside diameter of facility being installed. For elliptical or rectangular facilities, this will be the largest dimension of the height or width in inches. For round facilities, this will be the dimension of the diameter in inches. ***Always*** denote the size of the non-round facility (H x W) in the notes field.
Parallel Quantity	ParaQT	Select the number of similar-sized conduits or pipes being installed together in parallel in the same excavation, trench, or bore shot. Specifically, when multiple conduits are bound together for installation, each conduit does not need to be surveyed individually. The top/center conduit must be surveyed, and the number of parallel pipes or conduits selected.
Encasement	Encas	Select "YES" or "NO" to denote whether or not the primary facility is being installed inside of a larger diameter encasement
Equivalent SUE Quality Level	SueQL	Select either "A" or "B" to denote the equivalent Subsurface Utility Engineering Quality Level based on the ASCE 38-02 Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data • **QL-A:** Denotes the utility was surveyed by direct observation • **QL-B:** Denotes the utility was surveyed by indirect observation
Encasement Material	EncasMat	Select the appropriate encasement material type if "YES" is selected for the "Encas" attribute field above. Select "NONE" if "NO" is selected from the "Encas" attribute field above.
Encasement Diameter	EncasDia	Select the appropriate diameter value of the encasement if "YES" is selected for the "Encas" attribute field, select the appropriate

[2] The intent for recording utilities with encasements is to capture the first point of conflict, when considering a top down excavation scenario. Therefore, in the event a utility is installed with multiple encasements, the intent is to record the appropriate attributes for the outermost encasement.

		diameter value of the encasement. Enter the maximum outside diameter of the encasement. This will be the largest dimension of the height or width in inches for elliptical or rectangular encasements. This will be the dimension of the diameter in inches for round facilities. ***Always*** denote the size of the non-round encasement (H x W) in the notes field.
Notes	Notes	In addition to noting the size of non-round facilities, and H x W dimensions of non-symmetrical duct arrays, this is a free -form field for any unique notes the surveyor wants to capture.

Table 5

2.2.2 DATABASE SCHEMA IN HTML FORMAT

http://www.michigan.gov/documents/mdot/MDOT_GUIDE_Database_HTML_544497_7.Htm

2.2.3 DATABASE SCHEMA IN XML FORMAT

http://www.michigan.gov/documents/mdot/MDOT_GUIDE_Database_XML_544656_7.zip

2.2.4 DATABASE SCHEMA IN GDB FORMAT

http://www.michigan.gov/documents/mdot/MDOT_GUIDE_Database_GDB_544496_7.zip

2.3 COLLECTION PROCEDURES AND PRACTICES

The surveyor responsible for data collection is expected to rely on their own field methods and techniques for simultaneously collecting spatial data and the associated attributes. Common field surveying applications that support this activity include Carlson SurveCE, Microsurvey Field Genius, Leica Captivate, Trimble Terrasync, etc. The surveyor is responsible for collecting the data and preparing a three-dimensional shapefile compliant with GUIDE standards. Using the GUIDE web portal, the surveyor is to submit the shapefile to the GUIDE database for MDOT review and acceptance.

Completed data is uploaded directly to the GUIDE spatial database through the web portal. The GUIDE web portal allows for the upload of zipped shapefiles. The result is three-dimensional linear features representing the surveyed utilities, stored in a secure, web-hosted spatial database accessible by approved users for future use.

The following prerequisites must be completed first in order to upload data to the GUIDE web portal, regardless of the method of data collection used.

2.3.1 PREREQUISITES FOR DATA COLLECTION

2.3.1.1 OBTAIN ACCESS TO THE GUIDE WEB PORTAL

Before any data collection begins on a project, the permit applicant or its designated surveying provider must obtain login credentials to access the GUIDE Web Portal.

2.3.1.2 VERIFY PERMIT APPLICANT CREDENTIALS WITH MISS DIG

After access has been granted to the GUIDE services, the permit applicant or its designee must log on to the GUIDE web portal and verify that the utility company's name is available for selection under the "UtilComp" attribute field. MISS DIG member services must be called at (800) 482-7161 to verify that the permit applicant is a participating member and that the permit applicant is listed under the appropriate facility types if the company name is not available. The GUIDE database of utility companies is maintained based on the MISS DIG database of member utility companies and their corresponding facility codes. In accordance with Public Act 174 of 2013, all owners/operators of utilities must be members of MISS DIG.

2.3.2 SURVEY METHODS

The surveyor will create linework and store attributes for that line in accordance with GUIDE standards, on the standard survey data collector. If the surveyor's data collector does not allow for this then the lines can be brought into desktop applications such as AutoCAD Map, qGIS or ArcGIS and attributed appropriately. This method may require taking detailed field notes so that the correct attributes may be linked to the appropriate linear features in the office.

Steps for the traditional method of collecting GUIDE data:

1. Survey the top of the utility at the 100' intervals and other required locations according to the standards contained herein.
2. Import the field-collected survey data into the CAD or mapping application of your choice.
3. Separate each segment of the surveyed utility that share all common attributes for that segment.
    a. EXAMPLE: 2,500 feet of gas main is installed. Each segment where any attributes changed must be separated out as its own utility segment. In this example, there was a size change from 6-inch plastic to 8-inch plastic, and a segment with a steel encasement. The segment of utility that is 6 inches in diameter will be a unique segment from that segment that is an 8-inch diameter. Likewise, the segment of the gas main that has a steel encasement is also a separate linear feature with attributes that define its encasement. This could also have been done in the field collection portion described in step one above, eliminating the need to perform this step in the office.
4. Assign the appropriate attributes to each utility segment surveyed according to the template found in section 2.2.1. This can also be done during the field data collection with field data collection software that allows for multiple attributes to be stored to a surveyed linear feature.
5. Check and validate all data collected and be aware of any elevations that must be computed based on a depth reading stored during field data collection.
6. Export separate shapefile(s) for each utility type.
7. Zip shapefiles and upload them to the GUIDE web portal as described in section 2.6.1.

2.3.3 SAFETY

GUIDE standards are not intended to place field personnel at any additional risk beyond normal industry practice. All parties involved must follow all applicable safety standards. Specific safety hazards to be aware of are working around open excavations, construction equipment and confined spaces. All field personnel must be properly trained in applicable

safety standards and be aware of possible safety hazards that may be present when working around specific utility types and construction sites. Knowledge of and ways to handle specific safety situations when working around a live gas main, or awareness of how to appropriately handle pipes with special coatings are all industry-specific safety functions that all parties involved must follow.

2.4 FIELD DATA FORMATTING, QC AND SUBMITTAL PREPARATION

Data collected will have to be formatted, attributes for each polyline surveyed must be populated, and the collected and attributed polylines must be exported as a shapefile for upload. The shapefile must be zipped along with the other supporting files that accompany a shapefile before upload.

2.4.1 SURVEY METHODS

Below is a link to a sample formatted .zip which is used for uploading data in shapefile format:

http://www.michigan.gov/**documents/mdot/MDOT_GUIDE_Shapefile_Sample_544524_7.zip**

Contents of a sample Zip file depicted in Figure 7. (Highlighted files are required for a shapefile to be valid):

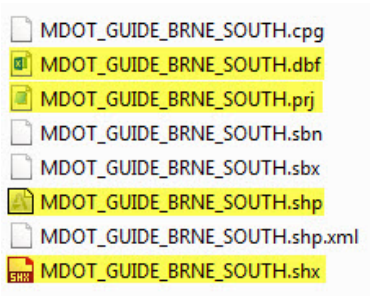


Figure 7

Sample Shapefile Format:

MDOT_GUIDE_WATR_SOUTH

FID	Shape *	AssetID	SegID	UtilComp	MDOTPer	InstMeth	LicNum	CollecBy	SurvInit	MethLoc
0	Polyline ZM		mkw1	DSGAUGTWP	1234	HDD (Hor Direct Drilling)	54049	SPICER	ESB	Tracer Wire
1	Polyline ZM		mkw2	DSGAUGRSC	1234	Open Cut	54049	SPICER	ESB	Tracer Tape
2	Polyline ZM		mkw3	DSGALLEGC	1234	Plowed	54049	SPICER	ESB	RFID
3	Polyline ZM		MKW6	DSGAUBURN	1234	Open Cut	54049	SPICER	ESB	Facility

FeaType	UtilType	InstDate	UtilMat	FacShape	UtilDia	ParaQT	Encas	SueQL	EncasMat	EncasDia	Notes	SHAPE_Leng
WATR	Service	4/4/2016	Aluminum	Round	6	1	No	A	-	-	Test	648.333335
WATR	Transmission	4/4/2016	Asbestos_Cement	Round	12	1	Yes	A	Steel	16	Test	358.606736
WATR	Distribution	4/4/2016	Brick	Round	10	1	No	A	-	-	Test	227.02258
WATR	Service	4/4/2016	Iron	Round	12	0	No	A	-	-	Test	380.888889

Figure 8

Populate the attributes using ArcMap or similar application as shown in Figure 8. This will require the use of the database template that is provided in section 2.2.4. Each line will be its own shape inside the shapefile, and each line will contain all required attributes. It is assumed the surveyor is familiar with the collection and creation of survey-grade GIS files, therefore little instruction is provided on collecting and submitting data in this format.

Sample workflow for shapefiles

1. Collect the geometry of each linear utility feature in the field.
2. Import each linear feature as a shapefile to ArcMap or comparable application.
3. Validate the geometry of all data and adjust the elevation for all points where the elevation is computed from a field-recorded depth.
4. Import that line into the appropriate blank template based on coordinate zone and utility type.
    a. Populate the required attribute fields.
    b. If using the template geodatabase, ArcMap will force users to enter attributes into all fields that require them.
    c. Export each utility type to its own shapefile. For example, all GAS features should be exported to a single shapefile.
    d. Zip the shapefile.
    e. Upload the shapefile to the GUIDE online portal.

2.5 QUALITY CONTROL AND QUALITY ASSURANCE

Each surveyor performing data collection must employ quality control procedures. Lines must be validated to be sure proper attribute values are entered. Points and linework will also need to be checked to be sure that the order of points and line represent the true geometry in the field. In addition to human errors, or random errors, surveyors need to be aware of instrumentation errors such as multipath, and pointing and leveling errors found with total stations, otherwise known as systematic errors.

The GUIDE web portal has built-in quality assurance measures to ensure that the data is joined correctly, and that all required fields contain values PREVIEW mode allows the user to verify that the file being uploaded is read correctly. In addition, the PREVIEW mode displays the resulting polyline on the screen that is created by the uploaded shapefile. As a user, this is the last chance to verify the shapefile being prepared will upload correctly.

2.6 SUBMITTAL PROCESS

Data collected must be uploaded as a zipped shapefile.

2.6.1 UPLOADING A SHAPEFILE

1. Click on the “Upload Shapefile” symbol. 
2. The “Upload Shapefile” window will appear, as shown in Figure 9.
3. Select your .zip file by clicking ADD SHAPEFILE.
4. Features are automatically shown in Preview mode (blue lines).
5. Click EXECUTE to start the upload process as shown in Figure 9.

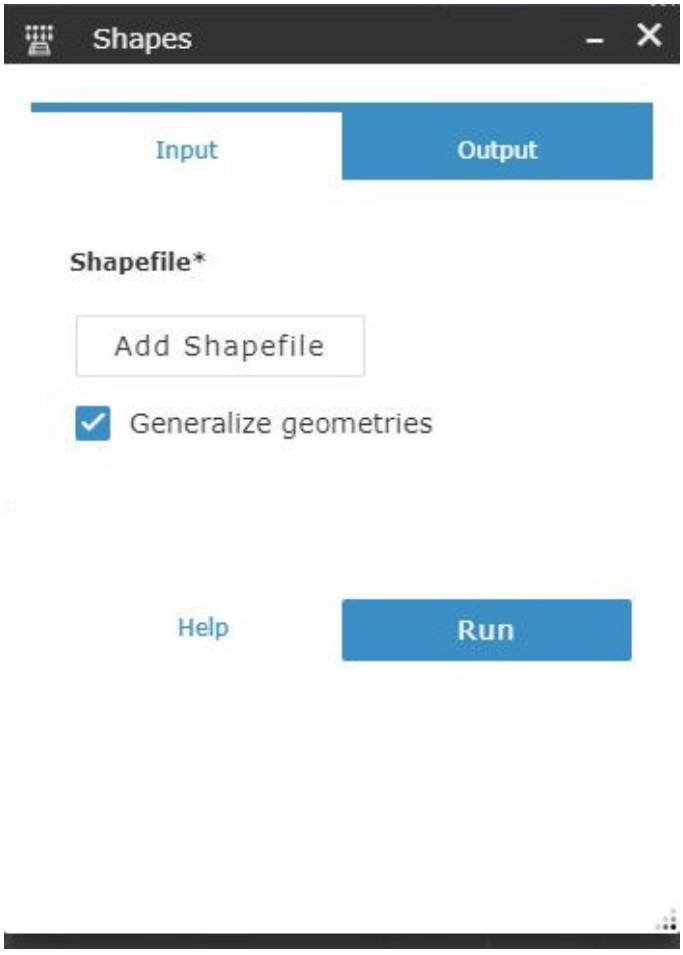


Figure 9

6. A status will show users if the items have been uploaded or not, and a results page can be reviewed by following the link under PROCESSING LOG, as shown in Figure 10.

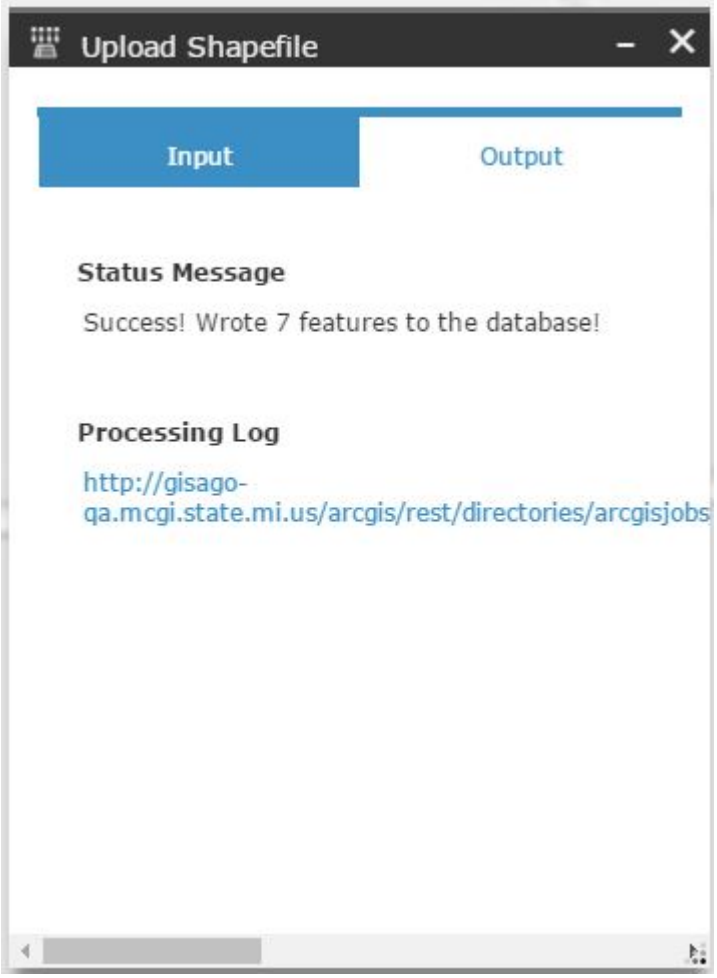


Figure 10

3 DATA ACCESSIBILITY, REVIEW AND ACCEPTANCE

3.1 ESTABLISHING USER ACCOUNTS

Section to be completed by MDOT

3.2 MDOT REVIEW

After the data has been submitted to MDOT through the GUIDE web portal, MDOT staff will review the submitted data. The data will be checked for the following items:

1. Data matches utility permit
   a. Size, type, utility company and general location of the utility as indicated on the permit matches what was surveyed.
2. Data complies with GUIDE Standards
   a. Data meets minimum requirements of survey observation frequency according to GUIDE standards.
   b. Required attributes have been completed.
   c. Spatial location visually correct.
   d. Geometry of data is 3D.
   e. All polyline vertices contain valid elevations (no zero elevations).

3.3 MDOT NOTIFICATION

At the completion of the GUIDE data review, MDOT will email the permit applicant the results of the GUIDE data review. The permit applicant will be notified that GUIDE data has been formally accepted by MDOT and no other action is necessary. If there are deficiencies, the permit applicant will be notified of deficiencies in GUIDE data discovered during MDOT review. A list of those deficiencies will be included in the email, with instructions to make the necessary corrections to the data and resubmit the data through the GUIDE web portal. If the data needs to be re-submitted, the initial dataset will be deleted from MDOT's database.

3.4 DATA SECURITY

Section to be completed by MDOT

4 DATA USE

4.1 DOWNLOAD GUIDE DATA

The data can be accessed by anyone with a user account to the GUIDE web portal. After navigating to the web portal, the user will be prompted for a username and password. Once logged in you will have access to all historical GUIDE data and will be able to upload new data as-needed. Most users will use the system to view, download, and upload data, while those users responsible for collecting data will use the same portal to contribute new GUIDE data.

If users choose to download data from the GUIDE portal, click "Download GUIDE Data", as shown in Figure 11. Users can select the data they wish to download by drawing an area of interest using the various AOI tools and selecting the appropriate output format. Currently the GUIDE web portal will allow a user to download data in Geodatabase GDB, shapefile, AutoCAD DXF, AutoCAD DWG, and MicroStation DGN file formats, as shown in Figure 12. The various output formats provide users with 3D utility data that can be used in all major CAD and GIS applications.

Figure 11

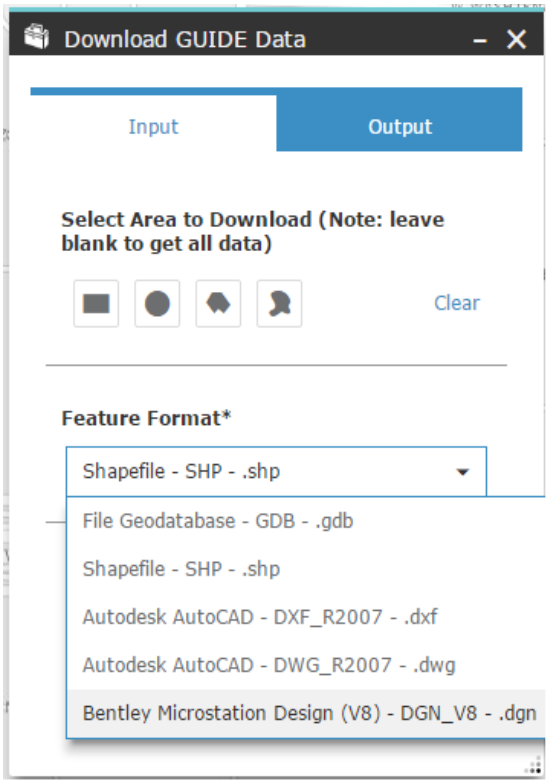


Figure 12

All users are required to read and accept the terms and conditions contained in the GUIDE Data Use Disclaimer prior to gaining access to the GUIDE web portal. The GUIDE disclaimer language will be developed by MDOT.

4.2 DOWNSTREAM APPLICATIONS

There are various downstream uses for data that is collected and stored on the GUIDE web portal, including use during project planning, project design and utility coordination.

4.2.1 DESIGN

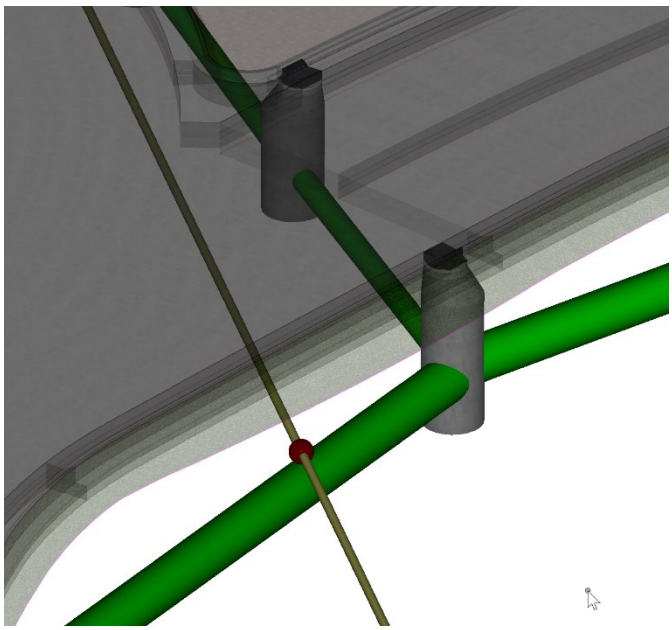


Figure 13

Consideration was given to design applications when developing GUIDE data standards, with specific focus on transportation utility design applications such as Bentley SUE/SUDA. The various formats available for download from the GUIDE web portal can be used directly in current engineering design workflows. Specifically, MDOT has proven the workflow can go directly from the 3D Shapefile output, to a 3D intelligent utility model in the Bentley SUE/SUDA application, as shown in Figure 13. This capability provides the user with the ability to visualize existing utility data in 3D and perform clash detection with proposed utilities during the design phase. Professional judgement must be employed to develop appropriate criteria for analyzing utility conflicts including conflict envelopes. These conflicts will vary greatly depending on a number of parameters, such as utility type and method of installation. MDOT intends to develop a guidance document for using the data available from the GUIDE web portal. The guidance document will be linked here upon completion.

4.2.2 PLANNING

GUIDE data is in GIS format natively, therefore the data can be used at the highest level of project planning. Data from GUIDE can be displayed with other MDOT assets in the Transportation Asset Management (TAMS) environment for network-level planning to identify major utility infrastructure that could impact highway planning

4.2.3 UTILITY COORDINATION

Data available through the GUIDE web portal is expected to be used across industries and agencies as a tool to enhance project utility coordination. As the database of utility data grows in volume, the more it will be used by consultants, utility companies, contractors and road agencies. The download options support all major CAD and GIS applications, making the GUIDE data portable and simple to plug into a road agency's existing process.

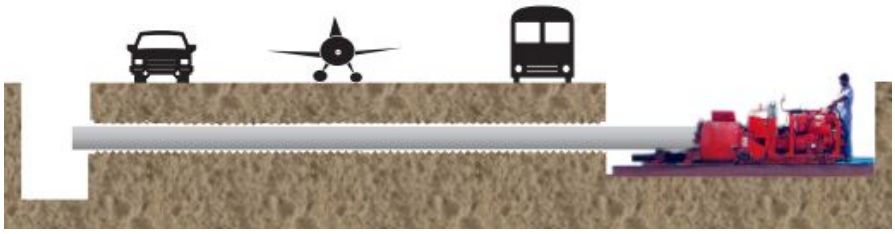
5 APPENDIX 1 TYPES OF INSTALLATION METHODS

5.1 HDD (HORIZONTAL DIRECTIONAL DRILLING)

Method of installing underground pipe by tunneling, using a horizontal directional drilling machine. The drilling machine can "steer" the auger head to achieve a target profile and drilling trajectory. This method requires documenting the utility location and depth at ground level at the appropriate locations as described in this manual, so that surveyors can document the spatial location of the underground utility.

5.2 BORING

Installation method where bore pits are created on each side of the actual bore as shown below, and the utility is bored underground in a straight line between bore pits.



5.3 OPEN CUT

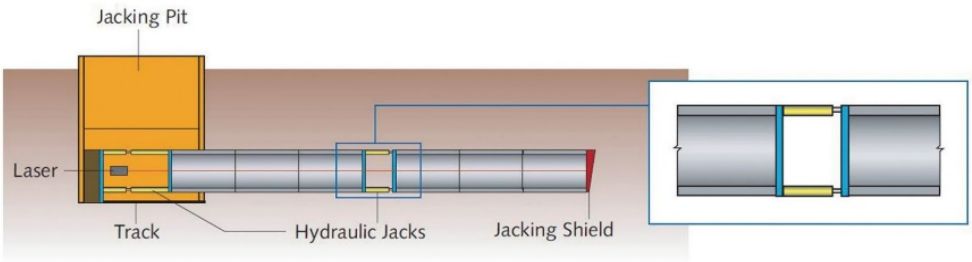
Method of installation where a utility is placed into an open cut trench or open excavation.

5.4 PLOWED

Method of installation where the utility placed in a trench that has been plowed using a special cable plow as shown below. Typically only used for communication conduits.

5.5 JACKING

Installation method where pipe is constructed and slid or “Jacked” through the ground with the use of hydraulics.

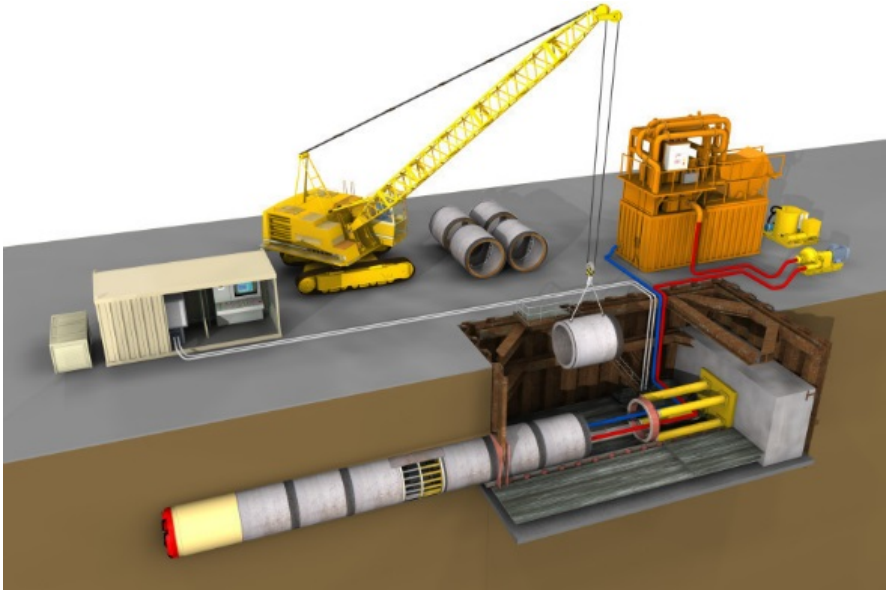


Typical Jacking Arrangement

Detail - Intermediate Jacking Station

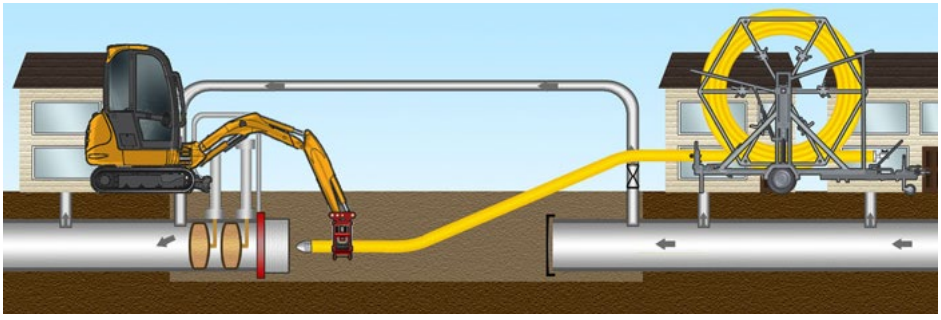
5.6 MICRO TUNNELING

Installation method where pipe jacking and boring are completed at the same time. The equipment is operated remotely from above ground and can be steered just like a directional drill.



5.7 INSERTION

Installation method where the utility is being inserted into an existing encasement that has been previously installed. Often used on gas main renewal projects.



5.8 DISCOVERED

Discovered has been included as an installation method domain option, so that existing utilities exposed during excavation, that are intended to remain in place, can be surveyed to GUIDE standards and uploaded to the GUIDE web portal.